

New Understanding of Algae

Within one week, British botanist Brian A. Whitton received two phone calls about cyanobacteria in local reservoirs—one caller wanted to know how to eradicate a potentially toxic bloom, the other wanted advice on marketing a related species as a health food. The anecdote, shared by Whitton at the 4th International Conference on Toxic Cyanobacteria, held 27 September–1 October 1998 at the Duke University Marine Laboratory in Beaufort, North Carolina, points to the complexities in understanding such organisms; some contain potent toxins and others promise health and therapeutic benefits.

An unprecedented number of laboratories worldwide are studying cyanobacteria, also known as blue-green algae, and participation at the September conference ballooned from early predictions, said conference cochair Wayne Carmichael, a cyanobacteria researcher and professor of aquatic biology and toxicology at Wright State University in Dayton, Ohio.

Microcystins were a common theme among many presentations. Toxic substances manufactured in the cells of some cyanobacteria, microcystins have been blamed for the liver failure and subsequent death of 75 dialysis patients at a clinic in Caruaru, Brazil, in 1996, said Carmichael. Other patients suffered nausea, vomiting, headache, and visual disruption, including blindness. The poisonings occurred in spite of water treatment methods in place that should have removed the contaminants from the clinic's water supply. Although microcystins have also been suspected in dialysis clinic deaths in Portugal, the Brazil fatalities were the only ones to date documented by analyses of blood serum and tissue samples.

Could this scenario occur in the United States or other developed nations? Cyanobacteria appear around the world in freshwater lakes and brackish waterways; some even tolerate seawater, and a few are terrestrial. Aquatic blooms flourish in the presence of increased nutrients, especially phosphorus. Carmichael reminded conference participants that water treatment procedures are only as good as the upkeep that accompanies them.

"We tend to pride ourselves on the fact that we have better water treatment [in the developed world]," he said. "But if you look at the water treatment process in place here, it's not much different than any other place in the world. I'm told that in most dialysis clinics in the United States, it's not a fail-safe procedure, that it needs to be maintained properly."

In a study of selected water utilities

throughout the United States and Canada during 1996 and 1997, Carmichael and his colleagues found microcystins in 65% of water samples that had not undergone treatment. A third of the positive samples registered levels of microcystins in excess of the recently adopted World Health Organization (WHO) drinking water standard of 1.0 µg/l of total microcystin. In a few cases, treated water samples contained microcystin levels higher than the WHO guideline.

Cyanobacteria species number in the thousands, and it is not known what percentage produce toxins. Besides microcystins, which attack the liver, other cyanotoxins have been identified that affect the nervous system and cause skin rashes. For more than a century, blue-green algae have been implicated in the deaths of livestock and other animals that drink contaminated water. People have historically avoided drinking from and bathing in lakes and other waters laden with surface scum, primarily because the algae produce a bad taste and odor.

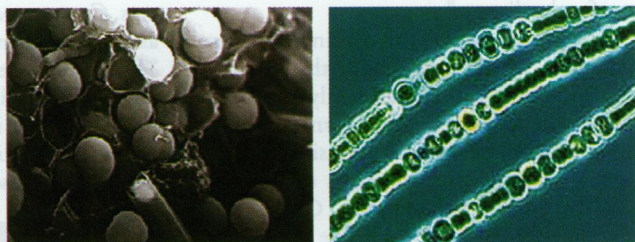
"Decreasing water quality throughout the world means that these blooms are present more often and for a longer duration, and people are using marginal water supplies more than they did in the past. They are forced to bathe in a bloom or to use water from a bloom," says Carmichael. "We are now starting to see acute poisonings, contact irritations, accidental ingestion, and low-dose exposure [that may result in] liver cancer."

Ian Falconer, a professor at the University of Adelaide Medical School in Australia, said reports of contaminated drinking water are pushing blue-green algae into the spotlight. "Lead, arsenic, and things like that are known environmental contaminants," Falconer said, "where cyanobacteria have only really become significant through eutrophication. There is an issue everywhere with respect to the water industry in meeting the WHO guidelines. The other issue is whether the most sophisticated treatments, which are more expensive, are actually [being used]."

Scientists from 35 countries made up the more than 150 participants at the conference, and presented on a range of topics including laboratory toxicity and developmental tests in animals, molecular analysis, toxin detection, regulation, and ecological studies. The beneficial aspects of cyanobacteria were also represented. While such algae

as *Microcystis*, *Anabaena*, and *Nodularia* produce chemicals lethal to humans and animals, some blue-green algae produce compounds that have anticarcinogenic, antibacterial, or antifungal properties.

Extracts of a blue-green algae have produced the antitumor drug cryptophycin, which is currently in clinical trials, said Richard Moore, a professor of chemistry at the University of Hawaii in Honolulu.



Blue-green bombshell. Cyanobacteria such as *Microcystis aeruginosa* (l) and *Nodularia* (r) contaminate much of the world's water supply with toxins that cause serious health effects.

Extracts from a marine blue-green algae collected in Guam have also exhibited antitumor properties, and appear to be chemically similar to dolastatin 10, a compound derived from marine mollusks that is also undergoing clinical trials as a cancer drug, Moore said.

Consumption of blue-green algae has also been touted as a health benefit by the dietary supplement industry. More than 1 million people in the United States and Canada consume blue-green algae in capsule or tablet form. Much of the product is harvested from blooms of *Aphanizomenon* in Oregon's Klamath Lake. Concurrent toxic blooms of *Microcystis aeruginosa* in 1996 prompted consumer concern about the safety of the product. Health officials subsequently determined a standard of 1 µg/g (equal to 1 ppm) to be a safe level of microcystins in supplements, said Duncan Gilroy, a public health toxicologist with the Oregon Health Division in Portland. But 50 of 67 samples obtained from harvesters, wholesalers, and retail outlets exceeded 1 ppm, he said. "We are concerned about people getting exposure to even low levels of microcystin for the long term," said Gilroy.

Alzheimer's Disease: A Basis in Bacteria?

According to a study published in the June 1998 issue of *Medical Microbiology and Immunology*, the bacterium *Chlamydia pneumoniae* may be linked with, or possibly even responsible for, Alzheimer's disease, a form of dementia that currently affects approximately 4 million U.S. citizens.